

Supervision of milk coagulation with scatter red LED light

Díaz-Gorgojo, N.¹⁾, Correa, E.C.^{1,3)}, Barreiro, P.^{1,2)}, Chamorro, M.C.³⁾ and Pérez de Rueda, R.^{1,2)}

¹⁾ Laboratorio de Propiedades Físicas y Técnicas Avanzadas en Agroalimentación. evacristina.correa@upm.es

²⁾ Departamento de Ingeniería Rural. Escuela Técnica Superior de Ingenieros Agrónomos.

³⁾ Unidad de Industrias Agroalimentarias. Escuela Universitaria de Ingenieros Técnicos Agrícolas.

^{1,2,3)} Polytechnic University of Madrid. Ciudad Universitaria s/n. 28040. Madrid. España.

Problem statement

For cheese production clotting time is predetermined using a proteolytic enzyme titration test (Chamorro and Losada 2002). Thus an expert operator decides the optimum cutting time (delayed versus clotting time) based on his own subjective evaluation of textural and visual properties of the curd (Castillo et al. 2000). Expert judgment of the operator usually gives acceptable results, yet variability in the optimal assessment of cutting time leads to modification in further cheese processing operations (pressing and ripening). The aforementioned reasons suggest the importance of an objective and non-destructive method to determinate optimal cutting time, which would allow indeed the automatic supervision of the cheese clotting process.

Several sensing devices have been reported for monitoring gel firmness during milk clotting, most of them based on near infrared reflectance spectroscopy (NIRs). O'Callaghan, O'Donnell, and Payne 2000, and mainly Castillo et al. 2000, have successfully used this technology to predict cutting and clotting time of milk. Castillo et al. 2000 monitored increasing diffuse reflectance during the coagulation process of goat's milk using a fibre optic sensor, based since turbidity and casein micelles size are affected by the process. NIRs is a rapid, non-destructive, and non-polluting technology but the complete equipment includes a spectrophotometer, which is a costfull and delicate instrument. In this work one other optical technique is tested by substituting NIRs and fibre optic with direct radiation using light emitter diodes (LEDs) in red wavelengths area. Red LEDs are small and cheap and allow the use of visible detectors to obtain diffuse reflectance profiles. **The goal of this work is a prospective study for the supervision of milk coagulation with scatter red LED light.**

Materials

For each experiment two samples were tested: fresh pasteurized milk and its curd. To obtain the curd 80 ml of milk were placed inside a circular (diameter 10 cm) glass bottle.

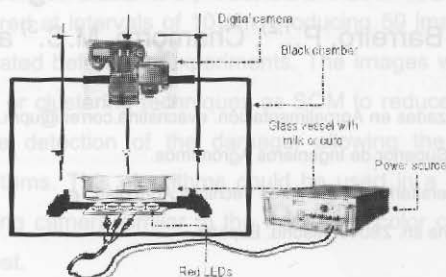


Figure 1: scheme of test procedure.

Results and discussion

Figure 2 shows the histogram of milk and curd, while milk presents 70% of pixels concentrated in the first 18 grey levels curd presents only 46%. So the frequency of darker grey level is higher for milk than for curd where red light is scattered. This effect can be visualized in Figure 3, the matrix of differences shows a pattern where red area for curd increases with respect to milk since an increase of diffuse reflectance occurs. These preliminary results will be the support for systematic testing, where: digital camera will be substituted by photo detectors, LEDs and photo detectors will be strategically locate at clotting vat and clotting process will be monitor at real time in continuous.

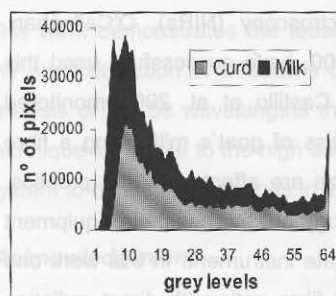


Figure 2: histogram of frequencies of n° of pixels for each grey level.

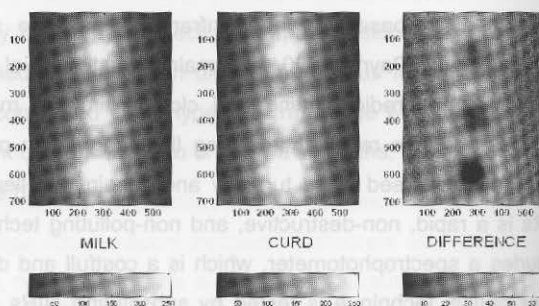


Figure 3: curd & milk images corresponding to red channel (405840 pixels) and visualization of differences.

References

- Castillo, M., F. A. Payne, C. L. Hicks, and M. B. Lopez. 2000. Predicting cutting and clotting time of coagulating goat's milk using diffuse reflectance: effect of pH, temperature and enzyme concentration. *International Dairy Journal* 10, no. 8: 551-62.
- Chamorro, M. C., and M. M. Losada. 2002. *El Análisis Sensorial de los Quesos*. Madrid: Ediciones A. Madrid Vicente and Mundi-Prensa.
- O'Callaghan, D. J., C. P. O'Donnell, and F. A. Payne. 2000. On-line sensing techniques for coagulum setting in renneted milks. *Journal of Food Engineering* 43, no. 3: 155-65.